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Moving Longwall Shield Supports at the York Canyon Coal Mine, Raton, N. Mex.

UNITED STATES DEPARTMENT OF THE INTERIOR

Information Circular 8747

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By Richard H. Oitto, David W. Wisecarver, and William E. Sikes

UNITED STATES DEPARTMENT OF THE INTERIOR
Cecil D. Andrus, Secretary

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CONTENTS

	Page
Abstract	1
Introduction	1
Acknowledgments	2
Longwall supports	3
Preparations for terminating longwall face	4
Removal of longwall equipment except shields	5
Removal of shield supports	7
Installation of equipment at next panel	15
Discussion	19

ILLUSTRATIONS

1.	Longwall shield support test site at York Canyon underground coal mine	2
2.	Hemscheidt 320 HSL two-legged shield support	3
3.	Diagrammatical view of the caliper shield	4
4.	Timber stored inside the shields	7
5.	Shield with roof canopy lowered free from roof	8
6.	Installing wooden crossbar over lowered shield	9
7.	Building wooden crib at gob side where shield was withdrawn	11
8.	Turning shield parallel to longwall face	11
9.	Preparing to pull shield onto sled	12
10.	Shield chained to sled ready for pulling to headgate	12
11.	Sled and shield on way to headgate with tailgate hoist rope being pulled behind	13
12.	Shield ready for pulling from sled onto trailer	13
13.	Shield loaded on trailer	14
14.	Shield and trailer being pulled to next panel	15
15.	Shield and trailer being backed into starting room	17
16.	Shield normal to panline at new face	17
17.	Shield extended against roof and shield ready for extending	18

MOVING LONGWALL SHIELD SUPPORTS AT THE YORK CANYON COAL MINE, RATON, N. MEX.

by

Richard H. Oitto,[1] David W. Wisecarver,[2] and William E. Sikes[3]

ABSTRACT

The Bureau of Mines and Kaiser Steel Corp. are cooperatively demonstrating the shield-type roof support in the longwall mining of a 10-1/2-foot-thick coalbed at the York Canyon mine near Raton, N. Mex. As part of the demonstration, the shield supports have been successfully and safely moved from a completed longwall face to a new longwall face. When these shield supports were moved in 1976 they were the largest and heaviest longwall support system in use in U.S. coal mines. The shield supports, preparations for moving them, the actual move, and installation at the new face are discussed.

INTRODUCTION

The Bureau of Mines and Kaiser Steel Corp. are cooperating in a program to demonstrate the shield-type roof support in the longwall mining of a 10- to 11-foot-thick coal seam at the York Canyon mine near Raton, N. Mex. The shield support system at the York Canyon mine, among the first to be introduced to U.S. coal mining, is being tested to determine its value and application to longwall mining problems from the standpoints of economics, engineering, and safety. Specifically, the objectives set forth by the Bureau of Mines are to (1) demonstrate and test a shield-type longwall support system under varied mining conditions, (2) evaluate the operation, advantages, and disadvantages of the equipment as applied in the United States, and (3) disseminate this information to the mining industry. In addition to original plans, the support system is equipped with a longwall lighting system to test and evaluate both the effectiveness and the impact of illumination on longwall mining.

The program includes mining of three longwall panels at the York Canyon mine with planned production of about 1,200,000 tons of raw coal. Panel layouts are given in figure 1. Panel 4N, now completed, had a face length of 550 feet. The panel length of 4N was shortened because two faults were intercepted, each of which had 5 feet of displacement at the final 4N face. Mine management knew that one fault might be encountered and that it had a

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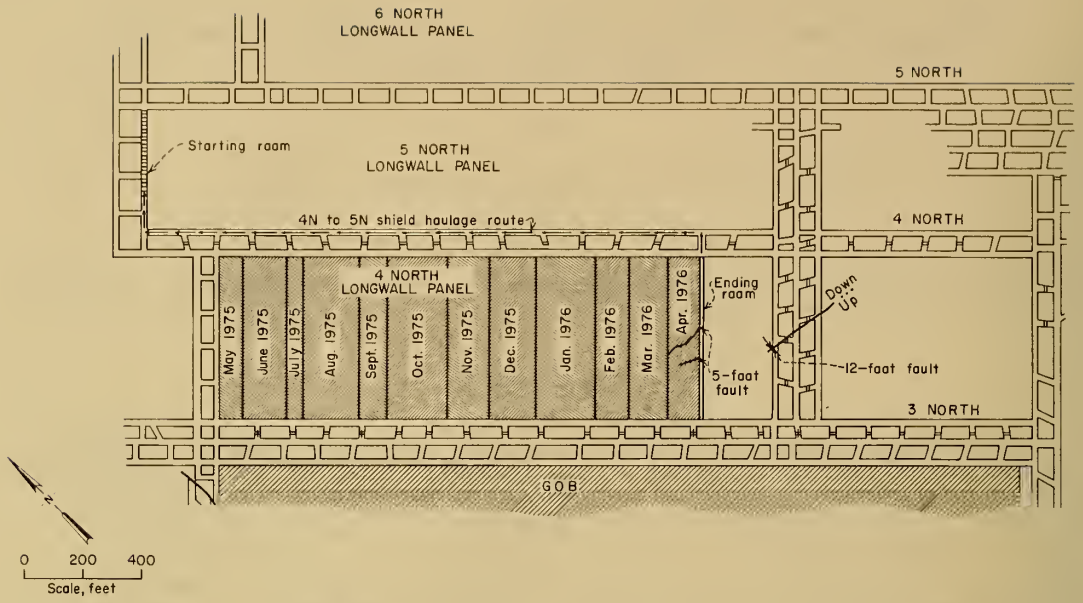


FIGURE 1. - Longwall shield support test site at York Canyon underground coal mine.

displacement of 12 feet ahead of where mining in 4N was originally scheduled to stop. The distance that the fault penetrated into 4N panel and its displacement in the panel could not be predicted. Mining of 4N was started and continued on the premise that the panel would be aborted at that point of mining, after intercept, that the fault-induced problems made longwall mining impractical. This stopping point was reached after 1,600 feet of mining and a fault displacement of 5 feet in each of two faults.

Initial contact with one fault was made some 120 feet before termination, and engineers carefully observed increases in displacement as mining progressed and problems in negotiating the shields forward. As conditions worsened, mine management decided to continue panel 4N to clear the next crosscut in 4N entry and then move the longwall to the adjacent 5N panel. Thus began the underground preparations and move of the largest and heaviest longwall shield support system in use at that time in U.S. mines. The methods and techniques of this move, specifically the handling and transport of the shields and the roof support methods used to facilitate the move and insure miner safety, are the primary subject of this Bureau of Mines report.

ACKNOWLEDGMENTS

Special acknowledgment is due Harry H. Elkin, longwall superintendent, York Canyon mine, who graciously contributed his knowledge and time to provide details about moving the shield supports and to review the draft of this report. Acknowledgment is made to Thomas A. Morgan, physical scientist, Denver Mining Research Center, who photographed several of the action scenes.

LONGWALL SUPPORTS

The 4N longwall support system had 116 shield supports of the type (Hemscheidt 320 HSL)[4] illustrated in figure 2. This support is a capiler shield type wherein (1) hydraulic or spring-actuated side sealing plates are used to provide skin-to-skin contact and reduce flushing of gob between the supports and (2) the canopy moves in a circular arc about the main hinge point as it is raised or lowered. Width of the supports is 59 inches. Maximum height is 142 inches, and closed height is 59 inches. Weight is about 11-1/2 tons.

Major and basic parts of the caliper shield are shown in figure 3. The base (A) is a twin-beam articulated arrangement where one beam can be lifted relative to the other, a feature which facilitates self-cleaning; through alternate raising and blocking, raising of the entire shield can be accomplished. The gob shield (B) links the base and canopy and is attached by heavy pins; the angled gob shield provides protection from and support of the gob. The two hydraulic legs (C) have a support capacity of 176 tons each,

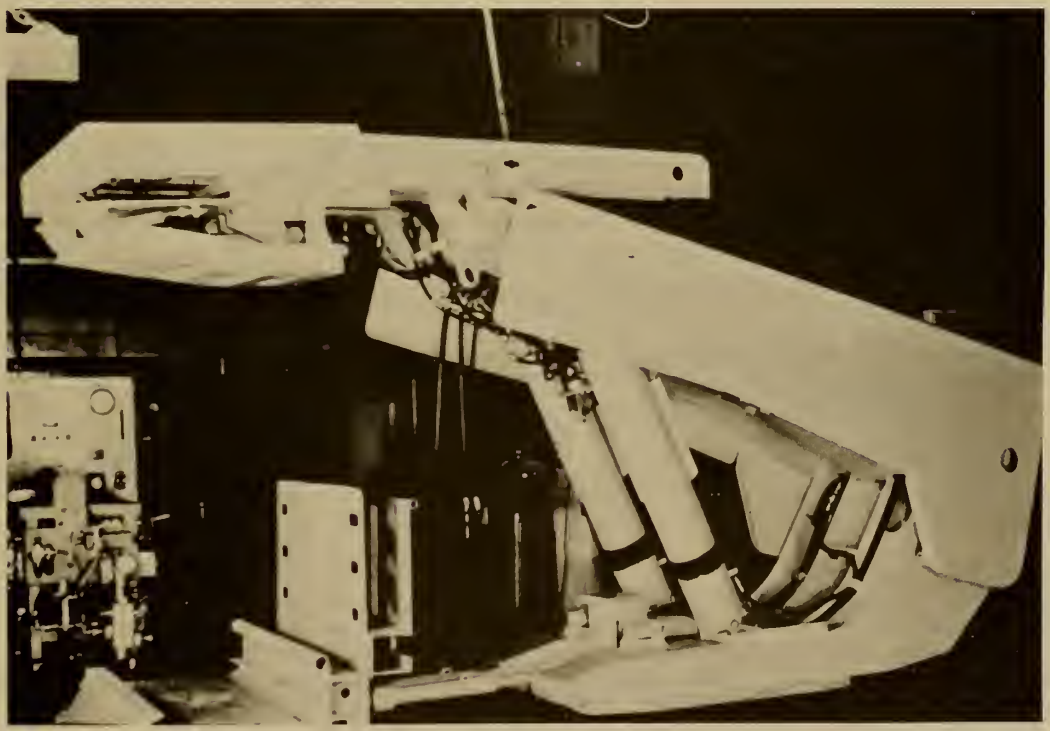
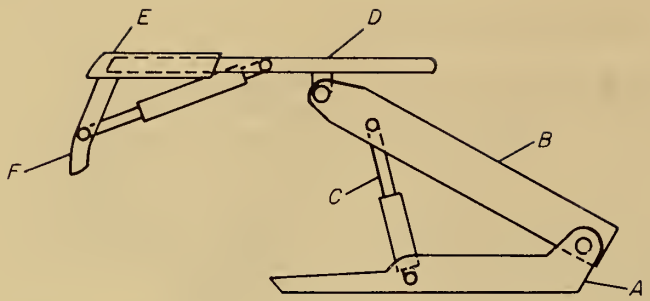


FIGURE 2. - Hemscheidt 320 HSL two-legged shield support.

[4]Reference to specific equipment does not imply endorsement by the Bureau of Mines.



A	Split-base skid	D	Roof canopy
B	Gob shield	E	Extensible roof canopy
C	Support leg (2)	F	Face guard

FIGURE 3. - Diagrammatical view of the caliper shield.

are double acting, and are equipped with mechanical extensions to enhance operation and increase range. A roof canopy (D) linked to the gob shield, covers the work area and transfers roof load to gob shield and support base. Additions and/or accessories to the roof canopy are the extension (E) and the face guard (F). The canopy extension has 20 inches of travel and permits the operator to adjust the canopy tip to the face as seam height changes. The face guard can be placed against the face to provide support and protection against coal bumps and falls. It is also useful in the overhead installation of wire mesh. Hydraulic components such as rams, valves, and control blocks round out the complete shield.

The shield is operated with the operator stationed on the support itself. However, hydraulic design is such that through interconnection and hose changes, a shield can be operated from control valves on an adjacent shield. This feature is extremely useful during the move of the shields after a longwall panel is terminated.

PREPARATIONS FOR TERMINATING LONGWALL FACE

Shutting down a shield-support longwall for moving the equipment to another panel requires preparations that are made while the last face cuts or webs are being mined. One preparation is placing wire mesh over the top and rear of the shields to prevent gob from flushing into the work site when a shield is withdrawn. Another preparation is making room for withdrawing the shields, which must be pulled toward the longwall face while being turned parallel to it.

The installation of wire mesh for restraining gob was started when 11 cuts (23 feet) of coal were left to mine. Starting with cut 1 and continuing through cut 10, heavy-duty chain-link fencing in 5-foot-wide sections was fed over the top of the roof canopies from the front and parallel to the face as each shield was lowered for advancing after the shearer passed by. The ends of the sections of fencing were joined with wire along the entire face, as were the sides when more sections of fencing were added as subsequent cuts were mined. Mesh that protruded in front of the roof canopies was conveniently kept out of the path of the shearer drums by attaching the mesh to the shield face guards, which were retracted as the shearer approached.

Chain-link fencing by itself is not strong enough to hold back gob when a shield is withdrawn, so support for the mesh was also installed. As cuts 2 through 6 were mined, 4-inch I-beams 15 feet long were placed parallel to the face over the roof canopies. One line of beams was installed the length of the face for each of the five cuts (cuts 2 through 6). The beams were placed under the mesh and chained to it.

As cuts 7 through 9 were mined, corrugated steel mats 1/8 inch thick by 1 foot wide by 15 feet long were used in place of I-beams. The original plan called for 6-inch I-beams because bad roof was expected and the rows of beams would be directly over the roof canopies when the shield supports were advanced for the last time. However, the roof appeared solid, so corrugated mats were used instead. Later, during shield removal the roof deteriorated more than expected, necessitating building cribs to support it.

To make room along the face for withdrawing the shields, they were not advanced when cuts 10 and 11 were taken, leaving a distance of about 4 feet from the face to the front of the roof canopy extensions in their forward position. With the extensions retracted, this distance was about 6 feet.

Because the shields were not advanced during final mining, arrangements had to be made for advancing the face conveyor for the final web (cut 11). Before the last cut was started, the connecting rods from the double-acting rams to the conveyor were disconnected from the conveyor, and a spacer was placed between the conveyor and connecting rods to push the conveyor to the face.

While the final cut was being taken, the 4-foot span of exposed roof being left above it was supported as the shearer advanced toward the headgate. The wire mesh was extended forward across the roof to the face and three-fourths of the way down the face for protection from falls of face coal. A wooden post wedged between the floor and roof in front of each shield held the mesh against the face. On top of each post and extending over the front of each roof canopy was a wooden plank 3 inches thick by 12 inches wide by 8 feet long that helped hold the mesh in place and supported the roof between the face and the roof canopies. Roof in the fault area was given additional support using roof bolt mats on 2-foot centers secured by 6-foot-long steel roof bolts grouted their entire length with resin. When the final cut was completed, loose coal in the face, headgate, and tailgate areas was shoveled by hand onto the conveyor.

REMOVAL OF LONGWALL EQUIPMENT EXCEPT SHIELDS

After mining was completed, the lump breaker on the stage loader, the stage loader, the headgate entry belt conveyor, the shearer, and the armored face conveyor were disassembled and removed in that order. Disassembly was limited to taking off protruding parts that could be damaged and separating major components to reduce weight or bulk. Components that could be towed easily were pulled behind scoop trams or scoop tractors; other components were hauled in the scoop of scoop trams, except for the shearer and face conveyor pans, which were hauled on trailers. Items needing shop work were taken out of the mine for repairs before being taken to the next longwall panel.

The lump breaker, stage loader, and belt conveyor did not require any special or unique removal procedure, but the shearer did. The procedure for removing the shearer consisted of opening the face conveyor chain so that the headgate drive of the conveyor could be moved aside, extending the pans of the face conveyor into the intersection of the face and headgate entry, running the shearer onto the extended panline, lifting the shearer, removing the pans under it, positioning two low-bed trailers hooked in tandem underneath the shearer, and lowering the shearer onto the trailers which in tandem formed a bed long enough for it. Chain hoists attached to crossbars bolted to the roof and posted at both ends raised and lowered the shearer. A scoop tram pulled the trailers and carried the shearer haulage chain in its scoop. Because the shearer was being replaced, it was hauled out of the mine.

After the shearer was removed, the headgate drive of the face conveyor was reattached and the conveyor chain was reconnected so that the face conveyor could haul 24 spill plates to the headgate. These spill plates were from face conveyor pans not needed at the next longwall face, which was shorter. Also, the face conveyor hauled to the face area crib blocks, cap pieces, and wedges which were stored inside the shields between the legs and gob shield until needed during recovery of the shield supports (fig. 4). When the face conveyor was no longer needed for hauling hardware to the headgate and timber to the face, the chain was opened and run to the headgate using the drive unit and hauled to the next panel minus the excess chain not needed at the shorter new face. Next removed were the emergency stop controls, electrical cables and water hoses in the conveyor cable-hose trough, and headgate drive complete with underframe and ram bar, which went as a unit via the shop for repairs to the next panel.

Before the conveyor tail drive and pans were removed, a loading dock was constructed at the headgate end of the face for convenience in loading pans, and later shield supports, onto a low-bed trailer. Dock construction commenced by taking up bottom at the intersection of the longwall face and headgate entry and then building a timber wall against the bank of the dock; this wall was the same height as the bed of the low-bed trailers. A 100-horsepower drum hoist set up in the entry provided the power for pulling the tail drive and pans of the face conveyor along the face and onto a trailer.

The conveyor pans were removed in sets of three, that is, the panline was disconnected at every third pan. Spill plates and ramp plates were left attached to the pans except for those on the extra pans not needed at the new face.

FIGURE 4. - Timber stored inside the shields.

REMOVAL OF SHIELD SUPPORTS

Removal of the face conveyor left an unobstructed work area between the face and shields for installing track from the headgate entry to the tailgate for hauling the shields to the headgate dock. The floor along the face was graded, and then pairs of 40-pound rails were laid parallel on wooden crossties. Steel hook-end tie rods established and maintained the track gage. Crossties and rods were both spaced 3 to 5 feet apart. An occasional rock bolt installed through a crosstie and anchored in the floor retarded sideward movement of the track.

The vehicle used on the track was a sled made from a thick, flat, rectangular steel plate wider and longer than the base of a shield support. The plate or sled slid directly on the rails and had guides underneath at both ends that touched the inner sides of the rails to keep the sled straight on the track. Eyes welded near each corner of the sled provided holes for chaining a load to the sled. A 100-horsepower drum hoist (tugger hoist) at the

headgate and a 40-horsepower hoist at the tailgate pulled the sled forward and backward along the track.

A steel ramp plate that abutted against the end of the track provided the grade for moving a shield upward from the floor onto the sled. The ramp had guide rails between which a shield slid to line it up for going straight onto the sled.

Shield removal started with the last shield at the tailgate and proceeded toward the headgate. The procedure for moving a shield from its place in line at the face to the headgate dock and onto a trailer follows:

1. Changed hydraulic hose arrangement so that shield to be removed was controlled from its neighbor on the headgate side, if this was not already the setup.

2. Moved split rings (collar) for regulating leg travel to top set of grooves on leg extensions so that shield legs could be retracted to minimum mining height. Lowered shield until roof canopy was free from roof (fig. 5).

FIGURE 5. - Shield with roof canopy lowered free from roof.

3. Retracted side plate and wired it to gob shield.

4. Cleaned debris from around connecting rods of double-acting ram, retracted ram, raised connecting rods above floor, and tied them in place.

5. Attached one sheave block to self-centering bracket for ram connecting rods and two more sheave blocks to lower part of a hydraulic prop set at the face between roof and floor 15 feet toward tailgate from shield to be withdrawn. (Rock bolts anchored in the floor were tried for anchoring sheave blocks at the face but pulled loose.) Passed wire rope from a 40-horsepower drum hoist at tailgate through sheave blocks to get a 3-to-1 mechanical advantage with end of rope attached to self-centering bracket on shield.

6. Retracted roof canopy extension and pinned it in place.

7. Lowered shield to lowest mining height.

8. Using the roof canopy as a work platform, replaced the post-plank set with a 1-foot-diameter wooden crossbar over the shield extending from the face to the gob (fig. 6). A single hydraulic prop placed near the face end of the crossbar pivoted the crossbar and held it against the roof.

FIGURE 6. - Installing wooden crossbar over lowered shield.

9. Placed single hydraulic props as needed for overhead support.

10. Removed coal and rock from between roof canopy and gob shield. Swung roof canopy flush against gob shield and chained it to gob shield.

11. Disconnected hydraulic hoses from adjacent shield and coupled loose ends to protect them from dirt and damage.

12. Changed hydraulic hose arrangement on second and third shields from end so that second shield was controlled from third shield. This control transfer prevented the second shield, which was supporting the roof next to the shield being moved, from being released should its controls be bumped by the shield being moved.

13. Pulled shield toward face while turning it to aim front end at tailgate. Sheave blocks were repositioned as necessary to turn shield. The single hydraulic props for temporary roof support were relocated as necessary while shield was being turned.

14. Placed a "T" support consisting of an I-beam on top of a hydraulic prop under the gob end of wooden crossbar previously installed with a single prop under its face end (item 8). The prop was offset 5 feet toward tailgate from crossbar to leave room for building a crib against gob where the shield came out.

15. Built an open crib with 10-inch by 10-inch by 3-foot blocks in cavity left by shield at gob side (fig. 7).

16. Pulled and jockeyed shield until it was parallel to face (fig. 8) and rear end lined up with ramp plate. Pulling and jockeying was done with tailgate and headgate hoists and various sheave block locations plus a hydraulic prop used horizontally to push against shield.

17. Raised ram connecting rods at rear of shield to clear floor and tied in place, chained track sled against ramp plate, and pulled shield up ramp plate and onto sled using headgate hoist (fig. 9).

18. Unchained sled, chained shield to sled using boomers (chain tighteners) to tighten chains, attached headgate hoist rope to sled (fig. 10), and pulled shield to dock at headgate (fig. 11). A worker followed the loaded sled to stop the hoist operator should the shield or sled hang up enroute. The tailgate hoist rope was pulled by the sled to the headgate for returning the sled.

FIGURE 7. - Building wooden crib at gob side where shield was withdrawn.

FIGURE 8. - Turning shield parallel to longwall face.

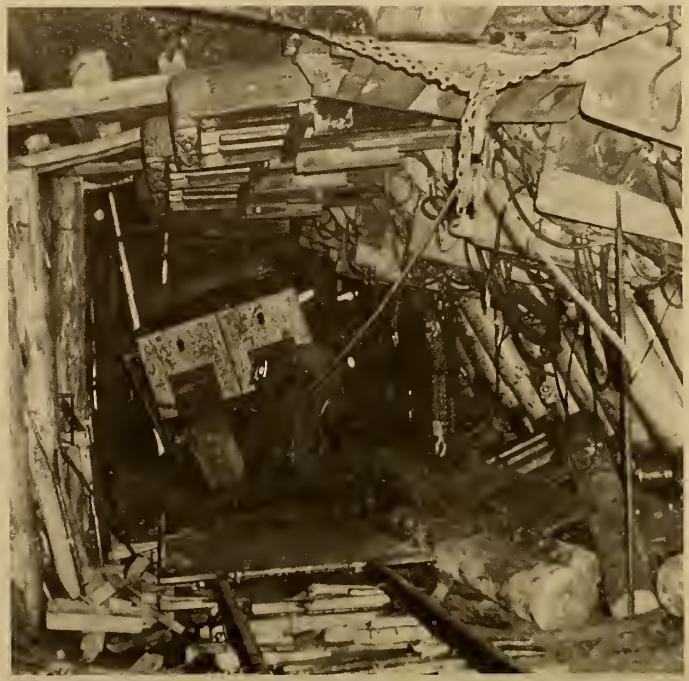


FIGURE 9. - Preparing to pull shield onto sled.

FIGURE 10. - Shield chained to sled ready for pulling to headgate.

FIGURE 11. - Sled and shield on way to headgate with tailgate hoist rope being pulled behind.

FIGURE 12. - Shield ready for pulling from sled onto trailer.

19. Unchained shield from sled, chained sled to track, and pulled shield onto low-bed trailer using headgate hoist (figs. 12 and 13).

20. Chained shield to trailer using boomers to tighten chains, and pulled trailer to next panel with a scoop tram (fig. 14).

21. Pulled sled back to tailgate end of track with any timber and equipmend needed loaded on it.

22. Replaced hydraulic props holding wooden crossbar with wooden posts 1 foot in diameter at each end. Center-posted crossbar later when space under crossbar was no longer needed for turning shields.

FIGURE 13. - Shield loaded on trailer.

Occasionally a shield tipped over while being pulled and turned. They were righted easily with no damage using a chain hoist attached to the roof canopy of the adjacent shield.

As shield recovery progressed toward the headgate, the track was taken up at the tailgate end as necessary to keep the end of the track ahead of shields being removed.

Also, as recovery progressed, additional open cribs spaced about 15 feet apart were built from the floor to the roof in the center of the opening, between the face and gob, to support the roof, which had started to exert heavy loads on the wooden crossbars.

After all the shields were removed, the hydraulic pump and reservoir for powering them were hauled by scoop tram to the next panel.

FIGURE 14. - Shield and trailer being pulled to next panel.

INSTALLATION OF EQUIPMENT AT NEXT PANEL

The starting room in which the longwall equipment was installed in the new panel was 9 feet high by 18 feet wide by 450 feet long. Roof bolt mats and steel roof bolts supported the roof. The bolts were 6 feet long and on 4-foot centers across and along the starting room. No support was needed for the 9-foot-high coal faces.

The longwall equipment was installed in the starting room and headgate entry in the reverse order that it was removed from the previous panel with one exception--the face conveyor panline, which came out before the shields, went in ahead of the shields. The face equipment was brought in through the tailgate entry, the shortest route with the most headroom from the old face to the new face.

The face conveyor pans came directly from the old face to the new face, where they were unloaded and installed upon arrival. Trailers carrying the pans were backed into the starting room from the tailgate end by scoop trams. After the set of pans on a trailer was tied to something solid, such as pans already installed on the floor, the scoop tram pulled the trailer out from under the pans. As the pans were connected, a wire rope from a drum hoist was

advanced through the bottom trough of the panline. The hoist later pulled the conveyor chain through the bottom trough. Drag created by pulling the chain along the floor through the 450-foot-long conveyor trough was reduced by removing some flights. Those left on the chain were 10 feet apart. The rest of the flights were put back on the chain after it was in place on the head and tail drive sprockets and could be moved under power.

After the conveyor panline was in place, the shield supports arrived directly from the old face, except, of course, the excess shields not needed at the new, shorter face, which were hauled elsewhere. The trailer hauling a shield was backed into the starting room (fig. 15) from the tailgate end to the spot where the shield was to be installed and was backed up to the panline at the sharpest angle obtainable, about 45°. The shield was unchained from the trailer, chained to the panline, and pulled off the trailer by jerking the trailer out from under it with the scoop tram.

To move a shield perpendicular to the panline from its 45° angle, first a scoop tram nudged it around until the shield was approximately normal to the panline (fig. 16) and opposite the clevis on the panline to which its ram-connecting rods would be connected. Then the chains, wire, and pins holding the ram-connecting rods, side plate, roof canopy, and canopy extensions in place were removed; the hydraulic hoses were connected to the shield alongside; and the shield was extended upward part way to make room for working under the roof canopy. A spare hydraulic pack powered the shields since the hydraulic pack at the old face was needed for the removal of shields there. Next the ram connecting rods were chained to the panline clevis, and by alternately operating the ram and taking up slack in the chain, the shield was pulled up to the panline and the connecting rods were connected to the clevis.

Alinement and spacing of the shield to its neighbor were accomplished by either pushing against the neighbor with the side plate to increase the spacing or using the side plate and a chain to pull the shield closer to its neighbor. After the shield was properly alined and spaced, the leg extensions were adjusted for the mining height and the roof canopy was set against the roof (fig. 17).

The new shearing machine arrived at the panel on two low-bed trailers in tandem, which were positioned at the tailgate end of the panline. Then the shearer was raised, the trailers were pulled out, the panline was extended, the shearer was lowered onto the panline, and the drums and cowls were attached.

After the shearer was placed on the panline, the head and tail drives of the face conveyor were attached to the panline and the installation of the conveyor chain was completed. With the face conveyor hardware in place, next installed were the power cables, pull-cord switch boxes, pull cord, shearer haulage chain, and a 950-volt transformer.

Last in the installation sequence were the pump station for the shields, methane sensor, gob end of the entry belt conveyor, stage loader, lump breaker, and master control for stage loader.

FIGURE 15. - Shield and trailer being backed into starting room.

FIGURE 16. - Shield normal to panline at new face.

FIGURE 17. - Shield (foreground) extended against roof and shield (background) ready for extending.

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DISCUSSION

The shield move posed an unusual problem to the York Canyon mine engineers and miners, who were experienced only in moving 5-1/2-ton chock-type supports from faces 6 to 7 feet high and over relatively smooth bottom. Upon completion of panel 4N, the miners were faced with moving a much heavier support (twice as heavy as the chocks) over a soft, faulted, and rolling floor. Further, roof control would be more difficult at 10-foot heights than at 7-foot heights.

Because of these differences, the move was made in an unhurried and cautious manner, particularly during the early stages. The initial plan for moving the shield supports was tentative and subject to changes. Changes in procedure were incorporated as soon as a need was evident. It required only the move of a few shields to determine the hookups, winching, and loading procedure to best move the support out of line and load it onto the sled. As the work progressed, the competency and teamwork of the miners improved, and lost motion decreased as a workable system was developed and practiced.

Forty-eight shifts were required to complete the move which was conducted on a two-shift-per-day, 5-day-workweek schedule. The crew size ranged from 5 to 10 workers, depending upon how many extra workers were available for training in the shield recovery and reinstallation activities. Some 1,400 tons of cumbersome and unwieldy steel supports were transported safely from panel 4N. There were no injuries.

In the 4N panel the shields were loaded on a sled which was winched along a rail track to a loading dock. This method was used because the floor was soft as well as uneven. Because floor conditions in the next panel (5N) will be the same, this method will be repeated.

A change planned for the 5N panel is to roof-bolt the entire roof in the ending room from headgate to tailgate and to use I-beams in lieu of steel mats for wire mesh support. I-beams will provide a more competent and consistent roof and substantially decrease the need of crib support along the abandoned face.

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